Single electrons in d+Au and p+p collisions at 200GeV

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Single electrons at $p_T > 1$ GeV/c provide an important probe to study heavy quark production. Hadrons with heavy flavors are unique tools in studying strong interactions which are described by Quantum Chromodynamics (QCD). Due to their large quark masses which require large energies ($\gtrsim 3$ GeV) at their creation, their production is sensitive to initial conditions and their spectra are sensitive to the later stage dynamical evolution in high energy nuclear collisions. Identification of charmed hadrons is difficult due to their short lifetime ($c\tau(D^0) = 124\ \mu$m), low production rates, and overwhelming combinatoric background. Measurements from the PHENIX and UA2 experiments gave large errors for the charm production cross section [1, 2]. Theoretical predictions for the RHIC energy region differ significantly [3, 4]. We report the single electrons measurement in d+Au and p+p collisions with STAR detector at RHIC. STAR also measured direct open charm production in d+Au collisions. These two independent analysis provide important cross check.

With the newly installed prototype time-of-flight system (TOFr) at STAR (in addition to its capability of hadron identification [5]), electrons/positrons could be identified at low momentum ($p_T < 3$ GeV/c) by the combination of velocity (β) from TOFr and the ionization energy loss (dE/dx) from the Time Projection Chamber(TPC) measurements. At higher p_T ($2-4$ GeV/c), electrons were identified directly in the TPC since hadrons have lower dE/dx due to the relativistic rise of the dE/dx for electrons. Gamma conversions $\gamma \to e^+e^-$ and $\pi^0 \to \gamma e^+e^-$ Dalitz decays are the dominant photonic sources of electron background. The e^+e^- pairs from these processes are present mainly at small pair invariant mass and/or small opening angle. Due to the large coverage of the TPC, the efficiency of finding pairs is very high for such processes. More than 95% of electrons from sources other than charm semileptonic decays have been measured with this method, while the remaining fraction ($< 5\%$) from decays of η, ω, ρ, ϕ and K was determined from simulations.

The non-photonic electron spectra were obtained by subtracting the previously described photonic background from the inclusive spectra. The results are shown in Fig. 1 for both p+p (triangles) and d+Au (circles) collisions at 200 GeV. Direct D^0 in d+Au collisions was also measured through event-mixing technique. The data points are shown in Fig. 1, too. Several model studies [6, 7] showed that semileptonic decays from open charm are the dominant non-photonic electrons in the range $1 < p_T < 4$ GeV/c. We performed a fit with the combined results of D^0 and electron distributions in d+Au collisions, assuming that the D^0 spectrum follows a power law in p_T and that the remaining electrons after background subtraction are from charm semileptonic decays. The results are depicted in Fig. 1. From this combined fit, the differential charm production cross section at mid-rapidity was obtained to be $d\sigma^{NN}_{c\bar{c}}/dy = 0.30 \pm 0.04(stat.) \pm 0.09(syst.)$ mb. Both PYTHIA and next-to-leading-order pQCD calculations underpredict the total charm cross section by at least a factor of 3. This is also evident from the comparison of the electron p_T distributions in Fig. 1. In addition, the slope from PYTHIA simulations is steeper than that of the data.

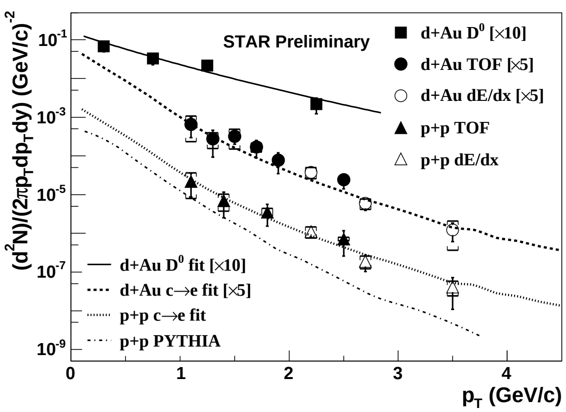

FIG. 1: Non-photonic electron p_T distributions from p+p collisions and d+Au collisions and reconstructed D^0 p_T distributions from d+Au collisions. Solid and dashed lines depict the combining fit results for the D^0 and electrons spectra in d+Au collisions. The dotted line is scaled down by a factor of N_{bin} from d+Au to p+p collisions. The dot-dashed line is from PYTHIA calculation [7].

[1] K. Adcox *et al.*, (PHENIX Collaboration), *Phys. Rev. Lett.* **88**, 192303 (2002).
[2] O. Botner *et al.*, *Phys. Lett.* B **236**, 488 (1990).
[3] R. Vogt, hep-ph/0203151, and references therein.
[4] J. Raufeisen and J.-C. Peng, *Phys. Rev.* D **67**, 054008 (2003).
[5] J. Adams *et al.*, (STAR Collaboration), submitted to *Phys. Rev. Lett.*, Sept. 2003 nucl-ex/0309012.
[6] P.L. McGaughey *et al.*, *Int. J. Mod. Phys.* **A 10**, 2999(1995).
[7] T. Sjöstrand *et al.*, Computer Physics Commun. **135**, 238 (2001).